DOCUMENT RESUME

ED 139 141 EC 100 716

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TITLE A Factor Analytic Study of Selected Tests of Specific Components of Academic Learning.
PUB DATE Apr 77
NOTE 14p.; Paper presented at the Annual International Convention, The Council for Exceptional Children (55th, Atlanta, Georgia, April 11-15, 1977)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Academic Achievement; Aptitude Tests; Elementary Secondary Education; *Factor Analysis; *General Education

ABSTRACT

A factor analytic study was designed to examine the factor structure of a battery of 17 tests administered to 100 students at the primary, intermediate, and advanced (grades 7-10) levels and to determine differences in factor structures for the three groups. The tests, measures of academic achievement, included the Wechsler Intelligence Scale for Children (WISC), the Wepman Test of Auditory Discrimination, the Detroit Test of Learning Aptitude, and the Peabody Picture Vocabulary Test (PPVT). The Full Component Model was used to analyze the data. Results indicated that the groups did not have similar factor structures and that the WISC measured all factors listed for the three groups with two exceptions. Results suggested that caution should be used in interpreting the Wepman and the PPVT because they appear to measure other factors than auditory discrimination and vocabulary. (Author/CL)

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A FACTOR ANALYTIC STUDY OF SELECTED TESTS OF SPECIFIC COMPONENTS OF ACADEMIC LEARNING

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December, 1976

Running Head: A Factor Analytic

EC 100716

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ABSTRACT

A factor analytic study was designed to obtain evidence related to the factor structure of a battery of 17 tests administered to 100 subjects and to assess whether or not the factor structures were different for each of the three groups (Primary, Intermediate, and Advanced). The Full Component Model was used to factor analyze the data. Results indicated that the groups did not have similar factor structures and that the *Wechsler Intelligence Scale for Children* (WISC) could measure all the factors listed for all three groups with two exceptions. Results further suggested that scores on the WISC should not be interpreted the same for all three groups.

A FACTOR ANALYTIC STUDY OF SELECTED TESTS OF SPECIFIC COMPONENTS OF ACADEMIC LEARNING

Concern with academic achievement has led educators to examine the ways in which children learn. This concern has been directed toward identification of factors associated with academic achievement, especially in the area of reading. Because of this concern a multiple factor theory associated wtih achievement has been validated (Johnson, 1957).

The multiple factor theory related to academic achievement has led to the measurement of multiple behaviors which theoretically contribute to academic learning. Many persons have suggested that the increased emphasis on testing behaviors assumed to measure specific components of learning has led to an acceptance of instruments that have little empirical support for their use (Bryan, 1974). This lack of empirical evidence has led to a demand for factor analytic studies (Hartman & Hartman, 1973). Educators, as yet, do not know if some instruments measure the construct they purport to measure. Additionally, it is not known if the construct measured is based on one or several entities. Lack of information also exists as to which behavior or behaviors many tests are, in fact, assessing.

Method

This study obtained evidence related to a battery of 17 tests previously used at the Child Study Clinic, University of Missouri-Columbia, to assess behaviors associated with academic achievement. The test battery included: the *Wechsler Intelligence Scale for Children* (WISC), the *Wepman Test of Auditory Discrimination (Wepman)*, the *Detroit*

Test of Learning Aptitude (DTLA), the *Peabody Picture Vocabulary Test* (PPVT), and the *Beery Developmental Test of Visual-Motor Integration* (VMI). The tests were assumed to measure, to some degree, four areas: auditory discrimination, auditory and visual memory, visual-motor integration, and intelligence. The case studies of 100 children were selected to use in the study. The 100 children were divided into three groups consisting of a Primary Group (grades 1-3), an Intermediate Group (grades 4-6), and an Advanced Group (grades 7-10).

Procedure

Research Question One: *What is the factor structure for each of the following groups: Primary, Intermediate, and Advanced?*

The Full Component Model (Gorsuch, 1974) was used to factor analyze the data in this study. This method can directly calculate the factor from the variables by applying weights. By altering the weights the same factor scores can produce all variables.

According to Gorsuch (1974, p. 18) "When one factors for all components, he assumes the existence of a set of factor scores which produce the original variable 'exactly'. Any observed error is a reflection of the inaccuracy of the model in that particular sample." Even in consideration of sampling error, the Full Component Model gives an excellent approximation of the original variables. Truncated components are the usual form of Full Component analysis. In using truncated components the smaller components are not analyzed.

In analyzing the components (factors) ". . .only elements of *S* greater than an absolute value of .40 could be interpreted if

the analysis was based on 100 individuals" (Gorsuch, 1974). In other words, the correlation between the test and the factor had to be greater than .40 before it could be analyzed. These absolute values greater than .40 were also referred to as factor loadings or factor value loadings.

The Full Component Model uses characteristic roots and vectors analysis and, therefore, it involves extensive calculations. To meet the needs of this study a computer program was used. A *Statistical Package Developed for the Social Sciences* (SPSS) was selected as the best computer program available for computing and analyzing the raw data. The Package was developed by Nie, Bent, and Hull (1970).

Analysis of the underlying constructs (theoretical components) began with the listing of the components and a description of the component as suggested by generally accepted authorities. Test interpretation used by authorities were as follows:

1. WISC: Classer and Zimmerman (1967).
2. VMI: Test Manual (Beery, 1967)
3. DTLA: Test Manual (Baker & Leland, 1967)
4. PPVT: Test Manual (Dunn, 1959)
5. *Test of Auditory Discrimination*: Test Manual (Wepman, 1958)

Research Question Two: *Are the factor structures for the three groups different from each other?*

Presently there is no procedure available to examine need-level factor scores for two groups to determine if they are significantly different from each other. A method developed by Veldman (1967) will yield a coefficient of factor congruence which will measure the degree to which pairs of factors are sim-

ilar to one another. According to Muliak (1972), there is no statistical test associated with this index. A common practice is to accept two factors as equivalent if the index of their factor similiarity is .90 or greater.

Results

Research Question One

As a result of data collected the following findings resulted: a factor analysis of 17 tests extracted seven factors for the Primary Group, seven factors for the Intermediate Group, and six factors for the Advanced Group. Specific findings of the study were as follows:

1. Primary Group Factors
    a. Integration
    b. Association
    c. Language
    d. Synthesis
    e. Speed and Accuracy
    f. Attention Span
    g. Organization
2. Intermediate Group Factors
    a. Integration
    b. Association
    c. Attention Span
    d. Memory
    e. Everyday Living Experiences
    f. Reading Background
    g. Organization

3. Advanced Group Factors
   a. Everyday Living Experiences
   b. Reading Background
   c. Memory
   d. Reasoning
   e. Attention Span
   f. Organization
4. Only a few tests measured a factor to a higher degree than the WISC. Those tests that correlated with a factor having a value factor loading of .10 or greater than the WISC were as follows:
   a. The VMI measured the Integration Factor for the Primary Group more effectively.
   b. Visual Attention Span for Objects and Auditory Attention Span for Related Syllables measured the Attention Factor for the Intermediate Group more effectively.
   c. Visual Attention Span for Objects and Auditory Attention Span for Unrelated Words measured Attention Span for the Advanced Group more effectively.
5. The VMI appeared to measure what it purports to measure for both the Primary and the Intermediate Groups.
6. As indicated from the results of this study, the *Wepman* is a factorially complex test; it measured five factors. None of the five factors appeared to be associated with auditory discrimination as explained in the Wepman manual. Furthermore, those factors measured by the *Wepman* were measured as well or in most cases better by the WISC.
7. Results from this study suggested that the PPVT measured four factors that were more effectively measured by six WISC subtests.

8. Results also indicated that the PPVT did not load on factors associated with a "listening vocabulary," nor did any of the tests that loaded on the same factors as the PPVT appear associated with vocabulary. Three of the seven WISC subtests that loaded on the same factors as the PPVT were performance tests.

Research Question Two

1. All intergroup correlations between the Primary and Intermediate Group factors were below the accepted index (.90) for equivalency; the two groups did not have similar factor structures.
2. Subjective comparison between the Advanced Group factors and the Primary and Intermediate Group factors suggested that the Advanced Group also had a different factor structure from the other two groups.
3. Although the factor structure for the three groups was different, there was a degree of overlap of factors among groups. Those factors found in two groups were as follows:
   a. Integration
   b. Association
   c. Memory
   d. Everyday Living Experiences
   e. Reading Background

   The two factors found in all three groups were Attention Span and Organization.
4. Even though the WISC, to some degree, did measure all the factors extracted in this study, it did not measure the same factors for all three groups. Those WISC subtests measuring the

same factor for the two groups were as follows:

a. Similarities measured Association for both the Primary and Intermediate Groups.

b. Information and Coding measured Reading Background for both the Intermediate and the Advanced Groups.

c. Block Design measured Organization for both the Intermediate and the Advanced Groups.

d. Picture Arrangement measured Organization for both the Primary and the Advanced Groups.

e. Comprehension measured Everyday Living Experiences for the Intermediate and the Advanced Groups.

The following conclusions were reached as a result of the findings related to the research questions posed in this study.

1. Results from this study indicated that a test battery consisting of the WISC and the VMI could measure all the factors listed for the Primary Group as effectively as the total battery used in this study.

2. Results indicated that the WISC and Visual Attention Span for Objects could be as effective in measuring factors for the Intermediate and the Advanced Groups as all the other tests combined.

3. Results suggested that the WISC scores should not be interpreted the same for the Primary, Intermediate, and Advanced Groups. Even though Organization and Attention Span were measured by the WISC for each group, a different subtest or combination of subtests measured these factors for each group.

Discussion

Results from this study may have implications for clinical diagnosticians and other educators and professionals involved in the assessment of learning problems. Implications derived were as follows:

1. Time and money might be spent more expediently by eliminating some of the tests typically administered during educational diagnoses. Some tests do not appear to add substantially to diagnostic information.
2. Caution should be used in interpreting Visual Attention Span for Objects for the Primary Group, Auditory Attention Span for Unrelated Words for the Primary and Intermediate Groups, and Auditory Attention Span for Related Syllables for the Primary and Advanced Groups as they appeared to measure factors other than Attention as defined in the DTLA test manual.
3. Caution should be taken in interpreting the *Wepman* as it appears to measure factors other than auditory discrimination.
4. Caution should be used in interpreting the VMI for the subjects beyond the sixth grade level.
5. Caution should be used in interpreting the PPVT at any grade level as it appears to measure factors other than vocabulary.

As a result of the study other research questions are suggested. For instance, would the factors for each group be different for a nonclinical population experiencing academic difficulties? Again, would the factors be different for groups who were not experiencing academic difficulties? It might also prove valuable to examine the factors from a population of nonstandard English speaking subjects. Adding or deleting tests from the battery might also

change the factor structure.

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